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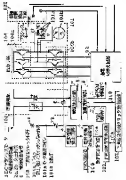
(54) DRIVE CONTROLLER OF DC BRUSHLESS MOTOR AND SELF SUCTION PUMP THEREWITH



(57)Abstract:

PROBLEM TO BE SOLVED: To provide the drive controller of a DC brushless motor capable of reducing consumption power and vibration and a self suction pump.

SOLUTION: The drive controller is provided with a voltage fluctuation corresponding control part 4 for determining duty of PWM in response to the

voltage fluctuation of a DC power source by a PWM instruction value determining the pulse width of PWM.

LEGAL STATUS

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CLAIMS

[Claim(s)]

[Claim 1] DC power supply equipped with the rectification smoothing circuit which supplies electric power to the motor drive coil of two or more phases, and the motor drive coil of said two or more phases, and rectifies AC power supply, The 1st switching element group arranged between the motor drive coil of said two or more phases, and + side of said DC power supply which are one feeder ways, The 2nd switching element group arranged between the motor drive coil of said two or more phases, and - side of said DC power supply which are the feeder ways of another side, A magnetic pole location detection means to detect the magnetic pole location of the rotator of a motor, and the supply voltage detector which detects and outputs the electrical-potential-difference value of said DC power supply which carry out voltage variation, The control section corresponding to the voltage variation which calculates the PWM command value which determines the pulse width of PWM according to the output signal of said supply voltage detector, and is outputted as a new PWM command value, The PWM signal generating circuit which outputs said PWM control signal of the pulse width according to said new PWM command value, The current detector which detects the electric supply current to the motor drive coil of said two or more phases, The drive control unit of DC brushless motor characterized by having the energization change circuit which is made to superimpose the magnetic pole location detecting signal which said magnetic pole location detection means outputs, and said PWM control signal, and is outputted to said 1st and 2nd switching element groups as an energization change signal.

[Claim 2] It has the overcurrent control section which will turn OFF said PWM control signal and will output it as a new PWM control signal till the next standup if the output signal value of said current detector exceeds the predetermined set point A. The drive control unit of DC brushless motor according to claim 1 characterized by for said energization change circuit making the magnetic pole location detecting signal which said magnetic pole location detection means

outputs, and said new PWM control signal superimpose, and outputting to said 1st and 2nd switching element groups as an energization change signal.

[Claim 3] The drive control unit of DC brushless motor according to claim 1 or 2 characterized by multiplying said PWM command value by B/C, and considering as said new PWM command value when said control section corresponding to voltage variation has the output C of said supply voltage detector larger than the lower limit B of the electrical potential difference of said DC power supply.

[Claim 4] It is [claim 1 to which it has the resistance arranged in the same track as said DC power supply, and said current detector is characterized by detecting the electric supply current from the electrical potential difference generated to the both ends of said resistance to the motor drive coil of said two or more phases thru/or] the drive control unit of DC brushless motor given in any or the first term among 3.

[Claim 5] It is the automatic feed water pump characterized by having equipped said control section corresponding to voltage variation with the timer with which the set point T was set up, and equipping any or the first term with the drive control unit of DC brushless motor of a publication claim 1 characterized by the period of said set point T making the duty of the pulse width of PWM 100% thru/or among 4.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention is used for the pump of household-electric-appliances devices, such as an air-conditioner and a hot-water supply machine, etc., and relates to the drive control unit of DC brushless motor which carries out the capacity adjustable by efficient PWM control, and the automatic feed water pump equipped with it.

[0002]

[Description of the Prior Art] Conventionally, the drive control unit of DC brushless motor was considered as the easy power-source configuration which considers cost, carries out direct full wave rectification of AC power supply, especially the source power supply as a drive power source of a motor, and carries out smooth [of the electrical potential difference] by the capacitor. Therefore, since a smoothing capacitor was a finite value while the voltage variation of a source power supply causes fluctuation of a direct DC-power-supply electrical potential difference, corresponding to the source-power-supply frequency of 50/60Hz, it had become a power source with a 100/120Hz electrical-potential-difference ripple.

[0003] The drive control unit of the conventional DC brushless motor is explained referring to a drawing below.

[0004] Drawing 11 is the functional block diagram of the drive control device of the conventional DC brushless motor.

[0005] The brushless motor in which 101 has motor drive coil 101a and rotator 101b of U phase, V phase, and W phase in drawing 11 , The location detection means which consists of a hall device to which 102 performs magnetic pole location detection of rotator 101b, The energization change circuit which 103 calculates the timing commutated with the signal detected with the location

detection means 102, and is outputted, An output means to drive a brushless motor 101 with the signal which 104 has 1st switching element group 104a and 2nd switching element group 104b, and is outputted from the energization change circuit 103, The DC power supply by which 105 supplies power to the output means 104, the PWM command value which is a capacity signal from the device by which 106 was equipped with the pump, The clock generation circuit which generates the clock signal 108 for triangular waves for 107 to generate an PWM signal, 109 is an PWM signal generating circuit which the clock signal 108 for triangular waves and the PWM command value 106 are inputted [signal generating circuit], and the duty of PWM is changed [signal generating circuit] by linear relation to the PWM command value 106, and generates an PWM signal. The energization change circuit 103 superimposes and outputs this PWM signal to the signal outputted to either 1st switching element group 104a or 2nd switching element group 104b. Thereby, while it doubles and chopping is carried out to this PWM signal, ON/OFF of 1st switching element group 104a of the output means 104 or the 2nd switching element group 104b is carried out. The current which flows to motor drive coil 101a of a brushless motor 101 by this is controlled, and since it can carry out adjustable [of the capacity of the brushless motor 101 which makes the moving vane of a pump drive], it can carry out adjustable [of the pump performance].
[0006] Drawing 12 is the circuit diagram showing an example of DC power supply.
[0007] In drawing 12 , the diode bridge where 201 carries out a 50/60Hz source power supply, and 202 carries out full wave rectification of the alternating voltage of a source power supply 201, and 203 are capacitors which carry out smooth [of the electrical potential difference by which full wave rectification was carried out]. 204 is a voltage regulator with the regulator ability for generating the electrical potential difference for control of the location detection means 102 or the energization change circuit 103.
[0008]
[Problem(s) to be Solved by the Invention] However, in the drive control unit of

the above-mentioned conventional DC brushless motor, it had the following technical problems.

[0009] (1) For the voltage variation of the DC power supply which carry out a direct development from the voltage variation of a source power supply, when the capacity as devices, such as a pump, was guaranteed with the mean value of voltage variation, it had the technical problem that the engine performance of devices, such as a pump, was greatly downed by the lower limit of voltage variation.

[0010] (2) When the engine performance of devices, such as a pump, was guaranteed by the lower limit of voltage variation, power consumption went up by the upper limit of voltage variation, and it had the technical problem on quality, such as a temperature rise.

[0011] (3) Usually, although it became unnecessary [the flow rate more than the flow rate whose pump built into a device is the rated point of a pump], since power consumption increased so that a flow rate becomes large, when a pump is a centrifugal pump, it had the technical problem on quality, such as a temperature rise.

[0012] (4) Since the capacitor for smooth was the capacity of finite, the amount of [of an electrical potential difference] ripple generated, the motor engine performance changed the instantaneous whole electrical potential difference, and it had the technical problem that vibration of devices, such as a pump, occurred on the frequency (it is [in the case of full wave rectification] 50/60Hz to 50/60Hz at a source power supply in the case of 100/120Hz and half-wave rectification) of an electrical-potential-difference ripple.

[0013] (5) In order to have considered as the power source which does not generate voltage variation, it had the technical problem that the cost of a power source went up.

[0014] This invention can reduce offer and pump vibration of a drive control unit of DC brushless motor which can carry out reduction of power consumption, and reduction of vibration, and aims at offering the drive control unit of DC brushless

motor from which only self-priming time amount can raise an engine speed, and can raise self-priming ability, and the automatic feed water pump equipped with it.
[0015]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem the drive control unit of DC brushless motor of this invention DC power supply equipped with the rectification smoothing circuit which supplies electric power to the motor drive coil of two or more phases, and the motor drive coil of said two or more phases, and rectifies AC power supply, The 1st switching element group arranged between the motor drive coil of said two or more phases, and + side of said DC power supply which are one feeder ways, The 2nd switching element group arranged between the motor drive coil of said two or more phases, and - side of said DC power supply which are the feeder ways of another side, A magnetic pole location detection means to detect the magnetic pole location of the rotator of a motor, and the supply voltage detector which detects and outputs the electrical-potential-difference value of said DC power supply which carry out voltage variation, The control section corresponding to the voltage variation which calculates the PWM command value which determines the pulse width of PWM according to the output signal of said supply voltage detector, and is outputted as a new PWM command value, The PWM signal generating circuit which outputs said PWM control signal of the pulse width according to said new PWM command value, The current detector which detects the electric supply current to the motor drive coil of said two or more phases, It consists of a configuration equipped with the energization change circuit which is made to superimpose the magnetic pole location detecting signal which said magnetic pole location detection means outputs, and said PWM control signal, and is outputted to said 1st and 2nd switching element groups as an energization change signal.
[0016] By this configuration, the drive control unit of DC brushless motor which can carry out reduction of power consumption and reduction of vibration can be offered.

[0017] Moreover, the automatic feed water pump equipped with the drive control unit of DC brushless motor of this invention is equipped with the timer with which the set point T was set up for said control section corresponding to voltage variation, and the period of said set point T consists of a configuration which makes the duty of the pulse width of PWM 100%.
[0018] By this configuration, pump vibration can be reduced and the automatic feed water pump equipped with the drive control unit of DC brushless motor with which only self-priming time amount can raise an engine speed, and can raise self-priming ability can be offered.
[0019]
[Embodiment of the Invention] The drive control unit of DC brushless motor of this invention according to claim 1 DC power supply equipped with the rectification smoothing circuit which supplies electric power to the motor drive coil of two or more phases, and the motor drive coil of said two or more phases, and rectifies AC power supply, The 1st switching element group arranged between the motor drive coil of said two or more phases, and + side of said DC power supply which are one feeder ways, The 2nd switching element group arranged between the motor drive coil of said two or more phases, and - side of said DC power supply which are the feeder ways of another side, A magnetic pole location detection means to detect the magnetic pole location of the rotator of a motor, and the supply voltage detector which detects and outputs the electrical-potential-difference value of said DC power supply which carry out voltage variation, The control section corresponding to the voltage variation which calculates the PWM command value which determines the pulse width of PWM according to the output signal of said supply voltage detector, and is outputted as a new PWM command value, The PWM signal generating circuit which outputs said PWM control signal of the pulse width according to said new PWM command value, The current detector which detects the electric supply current to the motor drive coil of said two or more phases, It considers as the configuration equipped with the energization change circuit which is made to superimpose the

magnetic pole location detecting signal which said magnetic pole location detection means outputs, and said PWM control signal, and is outputted to said 1st and 2nd switching element groups as an energization change signal, and the following operations are acquired by this configuration.
[0020] (1) In the control section corresponding to voltage variation, a new PWM command value can be determined corresponding to the magnitude of the electrical potential difference of DC power supply, and vibration by variation and electrical-potential-difference ripples, such as engine performance of devices, such as a pump, and power consumption, can be reduced by applying PWM control also with a power source with voltage variation and an electrical-potential-difference ripple.
[0021] Invention according to claim 2 is the drive control unit of DC brushless motor according to claim 1. It has the overcurrent control section which will turn OFF said PWM control signal and will output it as a new PWM control signal till the next standup if the output signal value of said current detector exceeds the predetermined set point A. It considers as the configuration which said energization change circuit makes superimpose the magnetic pole location detecting signal which said magnetic pole location detection means outputs, and said new PWM control signal, and outputs to said 1st and 2nd switching element groups as an energization change signal. In addition to an operation of claim 1, the following operations are acquired by this configuration.
[0022] (1) In an overcurrent control section, the current which flows to a switching element by applying current limiting is restricted, and since excessive power is not supplied to a motor while protecting a component, power consumption can be controlled.
[0023] (2) When DC brushless motor is used for a pump, at the time of the flow rate more than the rated flow as a pump, in an overcurrent control section, motor torque is restricted by applying current limiting, a flow rate is restricted as a result, and power consumption can be controlled.
[0024] Invention according to claim 3 is the drive control unit of DC brushless

motor according to claim 1 or 2, said control section corresponding to voltage variation considers as the configuration which multiplies said PWM command value by B/C, and is made into said new PWM command value when the output C of said supply voltage detector is larger than the lower limit B of the electrical potential difference of said DC power supply, and, in addition to claim 1 or an operation of 2, the following operations are acquired by this configuration.

[0025] (1) While being able to guarantee the engine performance of devices, such as a pump, by the lower limit B of voltage variation, increase of power consumption and increase of a temperature rise can be controlled, keeping the engine performance of devices, such as a pump, constant, even if the electrical potential difference of DC power supply is larger than a lower limit.

[0026] (2) By controlling the duty of PWM pulse width to B/C also to an electrical-potential-difference ripple in an instant, the change and vibration of a pump etc. of the engine performance of a device by the electrical-potential-difference ripple can be controlled, without making the capacity of a smoothing capacitor raise.

[0027] Invention according to claim 4 is the drive control unit of DC brushless motor given in any or the first term claim 1 thru/or among 3. It has the resistance arranged in the same track as said DC power supply, and said current detector considers as the configuration which detects the electric supply current from the electrical potential difference generated to the both ends of said resistance to the motor drive coil of said two or more phases. By this configuration In addition to an operation of any or the first term, the following operations are acquired claim 1 thru/or among 3.

[0028] (1) While being able to perform current detection with an easy configuration, peak shaving of the instantaneous value of a current is made.

[0029] Invention according to claim 5 is the automatic feed water pump which equipped any or the first term with the drive control unit of DC brushless motor of a publication claim 1 thru/or among 4, said control section corresponding to voltage variation is equipped with the timer with which the set point T was set up, the period of said set point T is considered as the configuration which makes the

duty of the pulse width of PWM 100%, and, in addition to an operation of any or the first term, the following operations are acquired claim 1 thru/or among 4 by this configuration.
[0030] (1) A motor output can be increased temporarily, self-priming ability can be raised, and shortening of self-support time amount can be attained.
[0031] The gestalt of the 1 operation of this invention to the following is explained referring to a drawing.
[0032] (Gestalt 1 of operation) Drawing 1 is the functional block diagram of the drive control device of DC brushless motor.
[0033] In drawing 1 a brushless motor and 101a 101 A motor drive coil, 101b a magnetic pole location detection means and 103 for a rotator and 102 An energization change circuit, 104 the 1st switching element group and 104b for an output means and 104a The 2nd switching element group, For DC power supply and 106, as for the clock generation circuit for triangular wave generating, and 108, an PWM command value and 107 are [105 / the clock signal for triangular waves and 109] PWM signal generating circuits, and since these are the same as that of a Prior art, they attach the same sign and omit the explanation.
[0034] The supply voltage detector which the resistance for partial pressures pressured partially in order that the drive control unit of DC brushless motor in the gestalt 1 of operation of this invention, 2a, and 2b may detect the electrical potential difference of DC power supply 105 in 1, and 3 unite with the magnitude the voltage signal by which the partial pressure was carried out, A/D conversion is carried out so that digital processing can be carried out, and outputs the time average value C of the result, and 4 are the control sections corresponding to the voltage variation into which the time average value C and the PWM command value 106 are inputted. As for the control section 4 corresponding to voltage variation, the lower limit B of DC power supply 105 is set up beforehand. When the time average value C as a result of the A/D conversion inputted is larger than a lower limit B, these ratios -- B/C is calculated, the result of having carried out the multiplication of B/C of the result of an operation to the duty corresponding to

the PWM command value 106 further inputted from the outside is anew determined as the duty of PWM, and new PWM command value 106' corresponding to the value is outputted to the PWM signal generating circuit 109 with an analog signal. The clock signal 107 for triangular wave generating and new PWM command value 106' are inputted, and the PWM signal generating circuit 109 changes the duty of PWM by linear relation to new PWM command value 106', and outputs PWM control signal 5'. 6 is resistance for the detectors of the current supplied to a brushless motor 101 from DC power supply 105. In proportion to the magnitude of a current, an electrical potential difference occurs to the both ends of resistance 6. The current detector where 7 detects the current detecting signal 8 which is the instantaneous value of a current from the electrical potential difference generated to the both ends of resistance 6, and 9 are PWM control signal 5' and an overcurrent control section into which the instantaneous value 8 of a current and the clock signal 108 for triangular waves are inputted. The overcurrent control section 9 outputs the new PWM control signal 5 which turned OFF PWM compulsorily to the timing which following PWM turns on to the energization change circuit 103, when the current detecting signal 8 exceeds from the predetermined set point.

[0035] Drawing 2 is the functional block diagram of an PWM signal generating circuit and an overcurrent control section, and drawing 3 is each signal waveform diagram of an PWM signal generating circuit and an overcurrent control section.

[0036] A triangular wave generating means for PWM signals by which 10 generates the triangular wave 11 for PWM signals from the clock signal 108 for triangular waves in drawing 2 and drawing 3 , The comparator to which 12 generates the triangular wave 11 for PWM signals, and new PWM command value 106' to PWM control signal 5', The comparator for current limiting to which 13 generates the overcurrent detecting signal 15 from the current-limiting reference voltage 14 which is the current detecting signal 8 and a predetermined electrical potential difference, 16 is a flip-flop with which an overcurrent detecting signal is inputted into a CLOCK terminal, PWM control signal 5' is inputted into D

terminal, the clock signal 108 for triangular waves is inputted into a terminal (outside 1) (outside 2), and a terminal is held at H. 18 is an AND circuit which consists of a logic IC which outputs the flip-flop output signal 17 (outside 3) of a flip-flop 16, and the AND of PWM control signal 5' as a new PWM control signal 5. The new PWM control signal 5 is superimposed by the output of the energization change circuit 103.

[0037]

[External Character 1]

$\overline{\mathrm{CLEAR}}$

[0038]

[External Character 2]

$\overline{\mathrm{PRESET}}$

[0039]

[External Character 3]

$\overline{\mathrm{Q}}$

[0040] About the drive control unit of DC brushless motor of the gestalt 1 of this operation constituted as mentioned above, the actuation is explained focusing on an overcurrent control section below.

[0041] The clock signal 108 for triangular waves is the square wave with same period of H level and period of L level. The frequency of this clock signal 108 for triangular waves turns into a carrier frequency of PWM. The triangular wave 11 for PWM signals is generated using the clock signal 108 for triangular waves. This triangular wave 11 for PWM signals goes up with the inclination determined with a circuit time constant from the standup of the clock signal 108 for triangular waves, and serves as a wave which descends with the almost same inclination from falling of the clock signal 108 for triangular waves. PWM -- a signal -- ** -- a triangular wave -- 11 -- voltage variation -- correspondence -- a control section --

four -- from -- inputting -- having -- new -- PWM -- a command -- a value -- 106 -- ' -- a comparator -- 12 -- inputting -- having -- if -- a comparator -- 12 -- an output signal -- PWM -- a signal -- ** -- a triangular wave -- 11 -- new -- PWM -- a command -- a value -- 106 -- ' -- being low -- the time -- H -- level -- becoming -- as -- PWM -- a control signal -- five -- ' -- becoming . On the other hand, if the output of the comparator 13 for current limiting which is the comparison result of the current detecting signal 8 and the current-limiting reference voltage 14 is set to H level to the timing shown in drawing 3 , the flip-flop output signal 17 which is the reversal output (outside 3) of a flip-flop 16 will serve as a signal wave form which is set to L level in the standup of the overcurrent detecting signal 15 outputted from the comparator 13 for current limiting, and is set to H level in falling of the clock signal 108 for triangular waves. Then, the AND of PWM control signal 5' and the flip-flop output signal 17 is taken, and the final new PWM control signal 5 is made to output in AND circuit 18. the new PWM control signal 5 -- the PWM signal generating circuit 109 -- PWM control signal 5' -- ON (H level) -- becoming -- the beginning -- instantaneous carrying current (current detecting signal 8) -- the current-limiting reference voltage level 14 -- **** -- it is the signal with which overcurrent control was made by an OFF (L level) condition being held until following PWM control signal 5' is turned on (H level), when [at which it hears] it becomes.

[0042] Since excessive power is not supplied to a motor while being able to restrict the current which flows to the switching element of the output stage means 104 momentarily and being able to protect a component, since the drive control device of DC brushless motor of the gestalt 1 of this operation is constituted as mentioned above, power consumption can be controlled.

[0043] Moreover, it sets to the control section 4 corresponding to voltage variation also to a changed part of the electrical potential difference in DC power supply 105, and the so-called instant voltage variation. By changing the duty of an PWM control signal by multiplying the PWM command value 106 by B/C, and considering as new PWM command value 106' A fixed electrical potential

difference without a ripple wave will be impressed to a brushless motor 101, and vibration of the pump which makes fundamental frequency fluctuation of the pump characteristics by the electrical-potential-difference ripple and the frequency of a ripple wave can be reduced.

[0044] Furthermore, generally as for a circulating pump, flow rate regularity is desired. That is, the flow rate more than the rated flow of a pump rated point becomes unnecessary. On the other hand, power consumption increases, so that a flow rate becomes large in a centrifugal pump. If two points are summarized above, above a rated flow, power consumption can be controlled by reducing a pump output, carrying out work sufficient as a pump.

[0045]

[Example] (Example 1) Drawing 4 is the graph which showed the ripple wave of the electrical potential difference outputted from DC power supply, and the current ripple wave of the capacitor for smooth.

[0046] In drawing 4 , 21 is the electrical-potential-difference ripple wave of DC power supply, and since the frequency of a source power supply is the full wave rectification of 60Hz case, a period is set to twice [about] as many 120Hz as this. 22 is the current ripple wave of the capacitor 203 for smooth.

[0047] even if it sets it as the capacitor capacity with which are satisfied of a permissible ripple current from drawing 4 -- an electrical-potential-difference ripple wave -- it turns out that a ripple voltage occurs also about 6V like 21.

[0048] (Example 2) Drawing 5 is the graph which showed the wave of the current which flows to a motor drive coil when current limiting is carried out by the overcurrent control section in the gestalt 1 of operation, and drawing 6 is the graph which showed the wave of the current which flows to a motor drive coil in case current limiting is not carried out.

[0049] even if current limiting is built and an PWM control signal is compulsorily turned off (L level) in drawing 5 -- a motor drive coil -- an inductance component -- **** -- since it is, it does not turn off rapidly but turns off with a predetermined inclination. Since energy is charged in proportion to the value of an inductance

component while the current is flowing to the motor drive coil, even if the electrical and electric equipment is not supplied to a motor drive coil from DC power supply 105, when the energy discharges, as for this, a current flows to motor winding.

[0050] Drawing 5 and drawing 6 show that overcurrent control starts in the operating point when the load torque of a motor is large.

[0051] (Example 3) Drawing 7 is the graph which showed the relation of the property (rotational frequency-torque) of DC brushless motor.

[0052] In drawing 7 , when there is an overcurrent control section 9, it is a continuous line, and when there is nothing, it expresses with the dotted line.

[0053] It turns out that current limiting did not require a rotational frequency in the low loading (0.135 or less N-m) of about 4200 (min-1) more than, but current limiting is built from drawing 7 in the heavy load (0.135 or more N-m) below 4200 (min-1).

[0054] (Example 4) Drawing 8 is the graph which showed the pump characteristics in the case where it does not prepare with the case where current limiting is prepared, when the current-limiting point is set as the rated point of a pump. This current-limiting point can be freely set up by changing the value of said resistance 6 for current detectors, and the value of the current-limiting reference voltage 14.

[0055] Although the flow rate is decreasing by current limiting being built above a pump rated flow from drawing 8 below at the pump rated head, reverse thereby especially as a pump, it turns out that power consumption decreases by about about 20W in a large flow rate side satisfactory.

[0056] (Example 5) Drawing 9 is the graph which showed the electrical-potential-difference dependency of the DC power supply of the PWM duty for attaining the rated point of a predetermined pump. In this example 5, the duty corresponding to 120V and the PWM command value 106 in a lower limit B is 100%.

[0057] Drawing 9 shows that the pump rated point is attained mostly (B/C) with the x100% PWM duty as supply voltage rises. For example, although

x100=85.7% becomes the result of an operation in the control section 4 corresponding to voltage variation when supply voltage is 140V (120/140), it is about 88% in practice. Few of this inequality is the increased effect of the switching loss of PWM.

[0058] (Example 6) Drawing 10 is the graph which showed the self-support time amount of an automatic feed water pump when arbitration carries out the timer setup-time pause of the control section corresponding to voltage variation.

[0059] Drawing 10 shows that self-priming time amount decreases about 25%, when the timer time amount which stops the control section 4 corresponding to voltage variation is set up almost on a par with self-priming time amount. In addition, in this example 4, it is a result at the time of making lower limit B=120V, time average value C=135V of DC-power-supply electrical-potential-difference detection, and the duty of the new-during timer period PWM control signal 5 into 100%.

[0060]

[Effect of the Invention] According to the drive control unit of DC brushless motor of this invention, and the automatic feed water pump equipped with it, the following advantageous effectiveness can be acquired as mentioned above.

[0061] According to invention according to claim 1, in the control section corresponding to (1) voltage variation, a new PWM command value can be determined corresponding to the magnitude of the electrical potential difference of DC power supply, and the drive control unit of DC brushless motor which can reduce vibration by variation and electrical-potential-difference ripples, such as engine performance of devices, such as a pump, and power consumption, by applying PWM control also with a power source with voltage variation and an electrical-potential-difference ripple can be offered.

[0062] According to invention according to claim 2, in addition to the effectiveness of claim 1, the current which flows to a switching element by applying current limiting in (1) overcurrent control section is restricted, and since excessive power is not supplied to a motor while protecting a component, the

drive control unit of DC brushless motor which can control power consumption can be offered.

[0063] (2) When DC brushless motor is used for a pump, in an overcurrent control section, the drive control unit of DC brushless motor which motor torque is restricted by applying current limiting, and a flow rate is restricted as a result, and can control power consumption can be offered at the time of the flow rate more than the rated flow as a pump.

[0064] According to invention according to claim 3, while being able to guarantee the engine performance of devices, such as a pump, by the lower limit B of (1) voltage variation in addition to claim 1 or the effectiveness of 2, the drive control unit of DC brushless motor which can control increase of power consumption and increase of a temperature rise can be offered, keeping the engine performance of devices, such as a pump, constant, even if the electrical potential difference of DC power supply is larger than a lower limit.

[0065] (2) By controlling the duty of PWM pulse width to B/C also to an electrical-potential-difference ripple in an instant, the drive control unit of DC brushless motor which can control the change and vibration of a pump etc. of the engine performance of a device by the electrical-potential-difference ripple can be offered, without making the capacity of a smoothing capacitor raise.

[0066] according to invention according to claim 4 -- claim 1 thru/or the inside of 3 -- the effectiveness of any or the first term -- adding -- (1) -- while being able to perform current detection with an easy configuration, the drive control unit of DC brushless motor which can do peak shaving of the instantaneous value of a current can be offered.

[0067] according to invention according to claim 5 -- claim 1 thru/or the inside of 4 -- the effectiveness of any or the first term -- adding -- (1) -- the automatic feed water pump equipped with the drive control unit of DC brushless motor which a motor output can be increased temporarily, and self-priming ability can be raised, and can attain shortening of self-support time amount can be offered.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The functional block diagram of the drive control device of DC brushless motor

[Drawing 2] The functional block diagram of an PWM signal generating circuit and an overcurrent control section

[Drawing 3] Each signal waveform diagram of an PWM signal generating circuit and an overcurrent control section

[Drawing 4] The graph which showed the ripple wave of the electrical potential difference outputted from DC power supply, and the current wave form of the capacitor for smooth

[Drawing 5] The graph which showed the wave of the current which flows to a motor drive coil in case current limiting is carried out

[Drawing 6] The graph which showed the wave of the current which flows to a motor drive coil in case current limiting is not carried out

[Drawing 7] The graph which showed the relation of the property (rotational frequency-torque) of DC brushless motor

[Drawing 8] The graph which showed the pump characteristics in the case where it does not prepare with the case where current limiting is prepared

[Drawing 9] The graph which showed the electrical-potential-difference dependency of the DC power supply of an PWM duty
[Drawing 10] The graph which showed the self-support time amount of an automatic feed water pump when arbitration carries out the timer setup-time pause of the control section corresponding to voltage variation
[Drawing 11] The functional block diagram of the drive control device of the conventional DC brushless motor
[Drawing 12] The circuit diagram showing an example of DC power supply
[Description of Notations]
1 Drive Control Unit of DC Brushless Motor
2a, 2b Resistance for partial pressures
3 Supply Voltage Detector
4 Control Section corresponding to Voltage Variation
5 New PWM Control Signal
5' PWM control signal
6 Resistance
7 Current Detector
8 Current Detecting Signal
9 Overcurrent Control Section
10 Triangular Wave Generating Means for PWM Signals
11 Triangular Wave for PWM Signals
12 Comparator
13 Comparator for Current Limiting
14 Current-Limiting Reference Voltage
15 Overcurrent Detecting Signal
16 Flip-flop
17 Flip-flop Output Signal
18 AND Circuit
21 Electrical-Potential-Difference Ripple Wave
22 Current Ripple Wave

101 Brushless Motor

101a Motor drive coil

101b Rotator

102 Location Detection Means

103 Energization Change Circuit

104 Output Means

104a The 1st switching element group

104b The 2nd switching element group

105 DC Power Supply

106 PWM Command Value

106' New PWM command value

107 Clock Generation Circuit for Triangular Wave Generating

108 Clock Signal for Triangular Waves

109 PWM Signal Generating Circuit

201 Source Power Supply

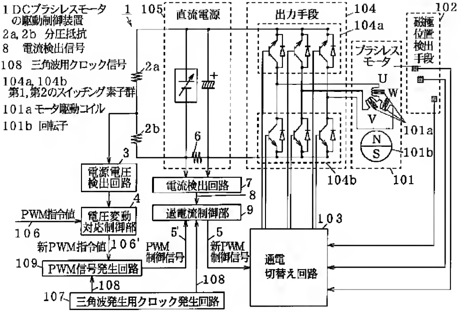
202 Diode Bridge

203 Capacitor

[Translation done.]

DRAWINGS

[Drawing 1]



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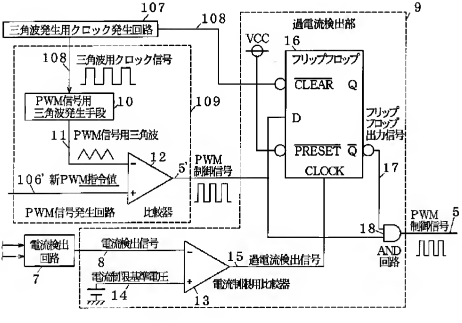

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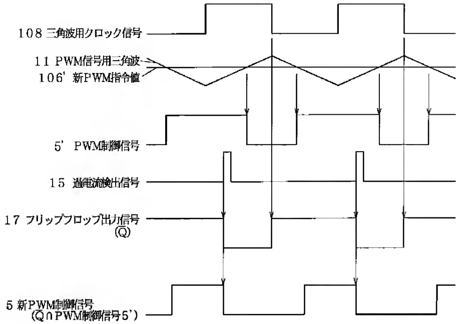

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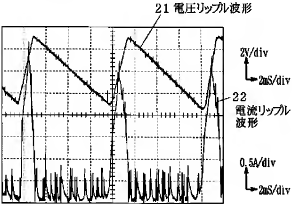

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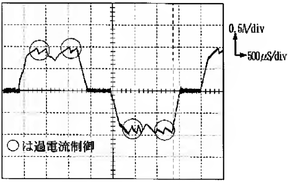

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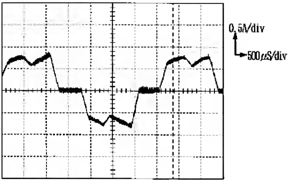

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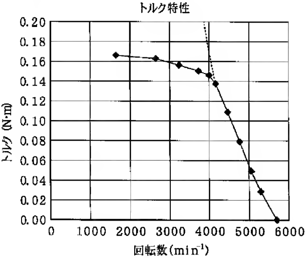

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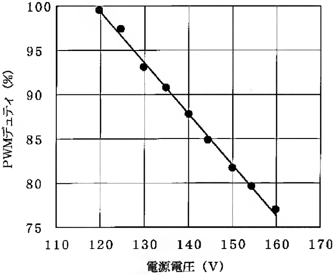
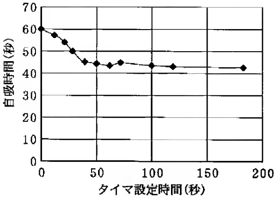


[Drawing 10]



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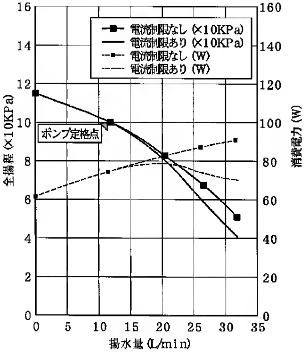
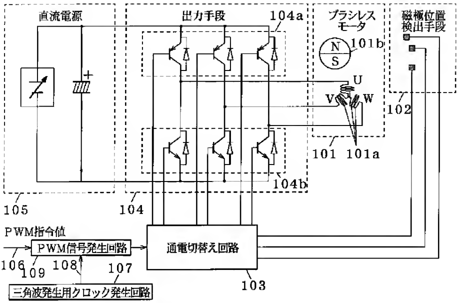


[Drawing 11]



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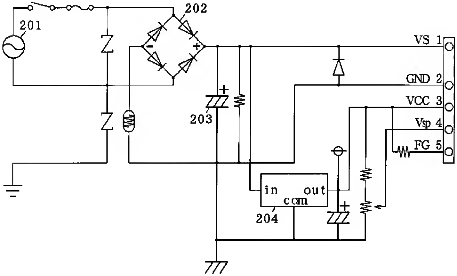

[Translation done.]

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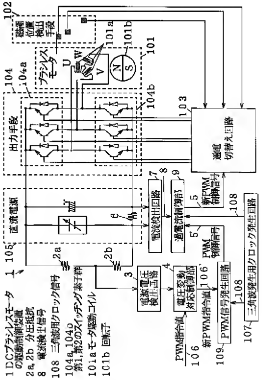
最終頁に続く

(54)【発明の名称】　ＤＣブラシレスモータの駆動制御装置とそれを備えた自吸式ポンプ

(57)【要約】
【課題】　本発明は、消費電力の低減及び振動の低減をすることができるＤＣブラシレスモータの駆動制御装置とそれを備えた自吸式ポンプを提供することを目的とする。
【解決手段】　この課題を解決するために本発明は、ＰＷＭのパルス幅を決定するＰＷＭ指令値を直流電源の電圧変動に応じてＰＷＭのデューティを決定する電圧変動対応制御部４を備えた構成を有する。



【特許請求の範囲】

【請求項1】複数相のモータ駆動コイルと、前記複数相のモータ駆動コイルに給電し交流電源を整流する整流平滑回路を備えた直流電源と、前記複数相のモータ駆動コイルと一方の給電線路である前記直流電源の＋側との間に配設された第1のスイッチング素子群と、前記複数相のモータ駆動コイルと他方の給電線路である前記直流電源の－側との間に配設された第2のスイッチング素子群と、モータの回転子の磁極位置を検出する磁極位置検出手段と、電圧変動する前記直流電源の電圧値を検出し出力する電源電圧検出回路と、ＰＷＭのパルス幅を決定するＰＷＭ指令値を前記電源電圧検出回路の出力信号に応じて演算し新ＰＷＭ指令値として出力する電圧変動対応制御部と、前記新ＰＷＭ指令値に応じたパルス幅の前記ＰＷＭ制御信号を出力するＰＷＭ信号発生回路と、前記複数相のモータ駆動コイルへの給電電流を検出する電流検出回路と、前記磁極位置検出手段が出力する磁極位置検出信号と前記ＰＷＭ制御信号とを重畳させ通電切替え信号として前記第1及び第2のスイッチング素子群に出力する通電切替え回路と、を備えたことを特徴とするＤＣブラシレスモータの駆動制御装置。

【請求項2】前記電流検出回路の出力信号値が所定の設定値Ａを超えると前記ＰＷＭ制御信号を次の立ち上がりまでＯＦＦにして新ＰＷＭ制御信号として出力する過電流制御部を備え、前記通電切替え回路が、前記磁極位置検出手段が出力する磁極位置検出信号と前記新ＰＷＭ制御信号とを重畳させ通電切替え信号として前記第1及び第2のスイッチング素子群に出力することを特徴とする請求項1に記載のＤＣブラシレスモータの駆動制御装置。

【請求項3】前記電圧変動対応制御部が、前記電源電圧検出回路の出力Ｃが前記直流電源の電圧の下限値Ｂより大きい場合、前記ＰＷＭ指令値にＢ／Ｃを乗じて前記新ＰＷＭ指令値とすることを特徴とする請求項1又は2に記載のＤＣブラシレスモータの駆動制御装置。

【請求項4】前記直流電源と同一線路に配設された抵抗を備え、前記電流検出回路が前記抵抗の両端に発生した電圧から前記複数相のモータ駆動コイルへの給電電流を検出することを特徴とする請求項1乃至3の内何れか一項に記載のＤＣブラシレスモータの駆動制御装置。

【請求項5】前記電圧変動対応制御部が、設定値Ｔが設定されたタイマを備え、前記設定値Ｔの期間はＰＷＭのパルス幅のデュティを１００％とすることを特徴とする請求項1乃至4の内何れか一項に記載のＤＣブラシレスモータの駆動制御装置を備えたことを特徴とする自吸式ポンプ。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、エアコン，給湯機等の家電機器のポンプ等に使用され、効率の良いＰＷＭ制御で能力可変をするＤＣブラシレスモータの駆動制御装置とそれを備えた自吸式ポンプに関するものである。

【０００２】

【従来の技術】従来より、ＤＣブラシレスモータの駆動制御装置は、モータの駆動電源として、コストを考え、交流電源とくに商用電源を直接全波整流し、コンデンサにより電圧を平滑する簡単な電源構成としていた。そのため商用電源の電圧変動が、直接直流電源電圧の変動を招くと共に、平滑コンデンサが有限値の為、商用電源周波数５０／６０Ｈｚに対応して、１００／１２０Ｈｚの電圧リップルをもった電源となっていた。

【０００３】従来のＤＣブラシレスモータの駆動制御装置について、以下図面を参照しながら説明する。

【０００４】図１１は従来のＤＣブラシレスモータの駆動制御装置の機能ブロック図である。

【０００５】図１１において、１０１はU相，V相，W相のモータ駆動コイル１０１ａ及び回転子１０１ｂを有するブラシレスモータ、１０２は回転子１０１ｂの磁極位置検出を行うホール素子等からなる位置検出手段、１０３は位置検出手段１０２により検出した信号により転流するタイミングを演算し出力する通電切替え回路、１０４は第1のスイッチング素子群１０４ａ及び第2のスイッチング素子群１０４ｂを有し通電切換え回路１０３から出力される信号によりブラシレスモータ１０１を駆動する出力手段、１０５は出力手段１０４に電力を供給する直流電源、１０６はポンプを備えた機器からの能力信号であるＰＷＭ指令値、１０７はＰＷＭ信号を生成するための三角波用クロック信号１０８を発生するクロック発生回路、１０９は三角波用クロック信号１０８及びＰＷＭ指令値１０６が入力されＰＷＭ指令値１０６に対し線形関係でＰＷＭのデュテイを変えＰＷＭ信号を発生させるＰＷＭ信号発生回路である。通電切替え回路１０３は、該ＰＷＭ信号を、第1のスイッチング素子群１０４ａ又は第2のスイッチング素子群１０４ｂのどちらかに出力する信号に重畳して出力する。これにより出力手段１０４の第1のスイッチング素子群１０４ａ又は第2のスイッチング素子群１０４ｂは該ＰＷＭ信号に合わせチョッピングされながらＯＮ／ＯＦＦする。これによりブラシレスモータ１０１のモータ駆動コイル１０１ａに流れる電流が制御され、ポンプの回転羽根を駆動させるブラシレスモータ１０１の能力を可変させることができるので、ポンプ性能も可変させることができる。

【０００６】図１２は直流電源の一例を示す回路図である。

【０００７】図１２において、２０１は５０／６０Ｈｚの商用電源、２０２は商用電源２０１の交流電圧を全波整流するダイオードブリッジ、２０３は全波整流された電圧を平滑するコンデンサである。２０４は位置検出手段１０２や通電切替え回路１０３の制御用の電圧を発生するためのレギュレータ機能をもった電源用ＩＣであ

る。

【0008】

【発明が解決しようとする課題】しかしながら、上記従来のＤＣブラシレスモータの駆動制御装置では、以下のような課題を有していた。

【0009】（１）商用電源の電圧変動から直接発生する直流電源の電圧変動のため、ポンプ等の機器としての能力を電圧変動の中間値で保証すると電圧変動の下限値でポンプ等の機器の性能が大きくダウンするという課題を有していた。

【0010】（２）電圧変動の下限値でポンプ等の機器の性能を保証すると電圧変動の上限値で消費電力が上昇し、温度上昇等の品質上の課題を有していた。

【0011】（３）通常機器に組込まれるポンプは、ポンプの定格点である流量以上の流量は不必要となるが、ポンプが遠心ポンプの場合流量が大きくなる程、消費電力が増大する為、温度上昇等の品質上の課題を有していた。

【0012】（４）平滑用のコンデンサが有限の容量の為電圧のリップル分が発生し、瞬間の電圧ごとでモータ性能が変化してしまい、電圧リップルの周波数（商用電源で５０／６０Ｈｚに対し、全波整流の場合は１００／１２０Ｈｚ，半波整流の場合は５０／６０Ｈｚ）でポンプ等の機器の振動が発生するという課題を有していた。

【0013】（５）電圧変動を発生しない電源とするには、電源のコストが上がるという課題を有していた。

【0014】本発明は、消費電力の低減及び振動の低減をすることができるＤＣブラシレスモータの駆動制御装置の提供、及びポンプ振動を低減することができ自吸時間のみ回転数を上げ自吸性能を上げることができるＤＣブラシレスモータの駆動制御装置とそれを備えた自吸式ポンプを提供することを目的とする。

【0015】

【課題を解決するための手段】上記課題を解決するために本発明のＤＣブラシレスモータの駆動制御装置は、複数相のモータ駆動コイルと、前記複数相のモータ駆動コイルに給電し交流電源を整流する整流平滑回路を備えた直流電源と、前記複数相のモータ駆動コイルと一方の給電線路である前記直流電源の＋側との間に配設された第１のスイッチング素子群と、前記複数相のモータ駆動コイルと他方の給電線路である前記直流電源の−側との間に配設された第２のスイッチング素子群と、モータの回転子の磁極位置を検出する磁極位置検出手段と、電圧変動する前記直流電源の電圧値を検出し出力する電源電圧検出回路と、ＰＷＭのパルス幅を決定するＰＷＭ指令値を前記電源電圧検出回路の出力信号に応じて演算し新ＰＷＭ指令値として出力する電圧変動対応制御部と、前記新ＰＷＭ指令値に応じたパルス幅の前記ＰＷＭ制御信号を出力するＰＷＭ信号発生回路と、前記複数相のモータ駆動コイルへの給電電流を検出する電流検出回路と、前記磁極位置検出手段が出力する磁極位置検出信号と前記ＰＷＭ制御信号とを重畳させ通電切替え信号として前記第１及び第２のスイッチング素子群に出力する通電切替え回路と、を備えた構成よりなる。

【0016】この構成により、消費電力の低減及び振動の低減をすることができるＤＣブラシレスモータの駆動制御装置を提供することができる。

【0017】また、本発明のＤＣブラシレスモータの駆動制御装置を備えた自吸式ポンプは、前記電圧変動対応制御部が、設定値Ｔが設定されたタイマを備え、前記設定値Ｔの期間はＰＷＭのパルス幅のデュティを１００％とする構成よりなる。

【0018】この構成により、ポンプ振動を低減することができ自吸時間のみ回転数を上げ自吸性能を上げることができるＤＣブラシレスモータの駆動制御装置を備えた自吸式ポンプを提供することができる。

【0019】

【発明の実施の形態】本発明の請求項１に記載のＤＣブラシレスモータの駆動制御装置は、複数相のモータ駆動コイルと、前記複数相のモータ駆動コイルに給電し交流電源を整流する整流平滑回路を備えた直流電源と、前記複数相のモータ駆動コイルと一方の給電線路である前記直流電源の＋側との間に配設された第１のスイッチング素子群と、前記複数相のモータ駆動コイルと他方の給電線路である前記直流電源の−側との間に配設された第２のスイッチング素子群と、モータの回転子の磁極位置を検出する磁極位置検出手段と、電圧変動する前記直流電源の電圧値を検出し出力する電源電圧検出回路と、ＰＷＭのパルス幅を決定するＰＷＭ指令値を前記電源電圧検出回路の出力信号に応じて演算し新ＰＷＭ指令値として出力する電圧変動対応制御部と、前記新ＰＷＭ指令値に応じたパルス幅の前記ＰＷＭ制御信号を出力するＰＷＭ信号発生回路と、前記複数相のモータ駆動コイルへの給電電流を検出する電流検出回路と、前記磁極位置検出手段が出力する磁極位置検出信号と前記ＰＷＭ制御信号とを重畳させ通電切替え信号として前記第１及び第２のスイッチング素子群に出力する通電切替え回路と、を備えた構成としたものであり、この構成により、以下のような作用が得られる。

【0020】（１）電圧変動対応制御部において、直流電源の電圧の大きさに対応して新ＰＷＭ指令値を決定し、ＰＷＭ制御をかけることで電圧変動及び電圧リップルをもった電源でもポンプ等の機器の性能、消費電力等のバラツキ及び電圧リップルによる振動を低減することができる。

【0021】請求項２に記載の発明は、請求項１に記載のＤＣブラシレスモータの駆動制御装置であって、前記電流検出回路の出力信号値が所定の設定値Ａを超えると前記ＰＷＭ制御信号を次の立ち上がりまでＯＦＦにして新ＰＷＭ制御信号として出力する過電流制御部を備え、

前記通電切替え回路が、前記磁極位置検出手段が出力する磁極位置検出信号と前記新PWM制御信号とを重畳させ通電切替え信号として前記第1及び第2のスイッチング素子群に出力する構成としたものであり、この構成により、請求項1の作用に加え、以下のような作用が得られる。

【0022】（1）過電流制御部において、電流制限をかけることでスイッチング素子に流れる電流を制限し、素子を保護するとともに余分な電力をモータに供給しないので消費電力を抑制することができる。

【0023】（2）DCブラシレスモータをポンプに用いた場合、ポンプとしての定格流量以上の流量時、過電流制御部において、電流制限をかけることでモータトルクを制限し、結果として流量が制限され消費電力を抑制することができる。

【0024】請求項3に記載の発明は、請求項1又は2に記載のDCブラシレスモータの駆動制御装置であって、前記電圧変動対応制御部が、前記電源電圧検出回路の出力Cが前記直流電源の電圧の下限値Bより大きい場合、前記PWM指令値にB／Cを乗じて前記新PWM指令値とする構成としたものであり、この構成により、請求項1又は2の作用に加え、以下のような作用が得られる。

【0025】（1）電圧変動の下限値Bでポンプ等の機器の性能を保証できるとともに、直流電源の電圧が下限値より大きくてもポンプ等の機器の性能を一定に保ちながら消費電力の増大、温度上昇の増大を抑制できる。

【0026】（2）電圧リップルに対しても瞬時にPWMパルス幅のデューティをB／Cに制御することで、平滑コンデンサの容量をアップさせることなく、電圧リップルによるポンプ等の機器の性能の変化や振動を抑制できる。

【0027】請求項4に記載の発明は、請求項1乃至3の内何れか一項に記載のDCブラシレスモータの駆動制御装置であって、前記直流電源と同一線路に配設された抵抗を備え、前記電流検出回路が前記抵抗の両端に発生した電圧から前記複数相のモータ駆動コイルへの給電電流を検出する構成としたものであり、この構成により、請求項1乃至3の内何れか一項の作用に加え、以下のような作用が得られる。

【0028】（1）簡単な構成で電流検出ができると共に、電流の瞬時値のピークカットができる。

【0029】請求項5に記載の発明は、請求項1乃至4の内何れか一項に記載のDCブラシレスモータの駆動制御装置を備えた自吸式ポンプであって、前記電圧変動対応制御部が、設定値Tが設定されたタイマを備え、前記設定値Tの期間はPWMのパルス幅のデューティを100％とする構成としたものであり、この構成により、請求項1乃至4の内何れか一項の作用に加え、以下のような作用が得られる。

【0030】（1）一時的にモータ出力を増大させ自吸性能を向上させることができ自給時間の短縮化を図ることができる。

【0031】以下に本発明の一実施の形態について、図面を参照しながら説明する。

【0032】（実施の形態1）図1はDCブラシレスモータの駆動制御装置の機能ブロック図である。

【0033】図1において、101はブラシレスモータ、101aはモータ駆動コイル、101bは回転子、102は磁極位置検出手段、103は通電切替え回路、104は出力手段、104aは第1のスイッチング素子群、104bは第2のスイッチング素子群、105は直流電源、106はPWM指令値、107は三角波発生用クロック発生回路、108は三角波用クロック信号、109はPWM信号発生回路であり、これらは従来の技術と同様のものであるので、同一の符号を付してその説明を省略する。

【0034】1は本発明の実施の形態1におけるDCブラシレスモータの駆動制御装置、2a，2bは直流電源105の電圧を検出する為に分圧する分圧用抵抗、3は分圧された電圧信号をその大きさにあわせデジタル処理できるようにA／D変換され、その結果の時間平均値Cを出力する電源電圧検出回路、4は時間平均値C及びPWM指令値106が入力される電圧変動対応制御部である。電圧変動対応制御部4は、予め直流電源105の下限値Bが設定されており、入力されるA／D変換の結果の時間平均値Cが下限値Bより大きい場合、これらの比B／Cを演算し、更に外部から入力されるPWM指令値106に対応したデューティに演算結果のB／Cを乗算した結果を改めてPWMのデューティと決定し、その値に対応した新PWM指令値106'をアナログ信号でPWM信号発生回路109に出力する。PWM信号発生回路109は三角波発生用クロック信号107及び新PWM指令値106'が入力され新PWM指令値106'に対し線形関係でPWMのデューティを変えPWM制御信号5'を出力する。6は直流電源105からブラシレスモータ101に供給される電流の検出回路用の抵抗である。電流の大きさに比例して、抵抗6の両端に電圧が発生する。7は抵抗6の両端に発生した電圧から電流の瞬時値である電流検出信号8を検出する電流検出回路、9はPWM制御信号5'，電流の瞬時値8，三角波用クロック信号108が入力される過電流制御部である。過電流制御部9は、電流検出信号8が所定の設定値より超えた時、次のPWMのONするタイミングまでPWMを強制的にOFFにした新PWM制御信号5を通電切替え回路103に出力する。

【0035】図2はPWM信号発生回路及び過電流制御部の機能ブロック図であり、図3はPWM信号発生回路及び過電流制御部の各信号波形図である。

【0036】図2及び図3において、10は三角波用ク

ロック信号１０８からＰＷＭ信号用三角波１１を生成するＰＷＭ信号用三角波発生手段、１２はＰＷＭ信号用三角波１１と新ＰＷＭ指令値１０６’とからＰＷＭ制御信号５’を生成する比較器、１３は電流検出信号８と所定の電圧である電流制限基準電圧１４から過電流検出信号１５を生成する電流制限用比較器、１６はＣＬＯＣＫ端子に過電流検出信号が入力され、Ｄ端子にＰＷＭ制御信号５’が入力され、（外１）端子に三角波用クロック信号１０８が入力され（外２）端子がＨに保持されるフリップフロップである。１８はフリップフロップ１６のフリップフロップ出力信号１７（外３）とＰＷＭ制御信号５’の論理積を新ＰＷＭ制御信号５として出力するロジックＩＣからなるＡＮＤ回路である。新ＰＷＭ制御信号５は通電切替え回路１０３の出力に重畳される。

【００３７】

【外１】

$$\overline{\mathrm{CLEAR}}$$

【００３８】

【外２】

$$\overline{\mathrm{PRESET}}$$

【００３９】

【外３】

$$\overline{\mathrm{Q}}$$

【００４０】以上のように構成された本実施の形態１のＤＣブラシレスモータの駆動制御装置について、以下その動作を過電流制御部を中心に説明する。

【００４１】三角波用クロック信号１０８はＨレベルの期間とＬレベルの期間が同じ矩形波である。この三角波用クロック信号１０８の周波数がＰＷＭのキャリア周波数となる。三角波用クロック信号１０８を用い、ＰＷＭ信号用三角波１１を発生させる。このＰＷＭ信号用三角波１１は、三角波用クロック信号１０８の立ち上がりから回路時定数で決定される傾きをもって上昇し、三角波用クロック信号１０８の立ち下がりからほぼ同じ傾きで下降する波形となる。ＰＷＭ信号用三角波１１と電圧変動対応制御部４から入力される新ＰＷＭ指令値１０６’は比較器１２に入力されると、比較器１２の出力信号はＰＷＭ信号用三角波１１が新ＰＷＭ指令値１０６’より低い時ＨレベルとなるようなＰＷＭ制御信号５’となる。一方、電流検出信号８と電流制限基準電圧１４との比較結果である電流制限用比較器１３の出力が、図３に示すタイミングでＨレベルになると、フリップフロップ１６の反転出力（外３）であるフリップフロップ出力信号１７は、電流制限用比較器１３から出力される過電流検出信号１５の立ち上がりでＬレベルになり三角波用クロック信号１０８の立ち下がりでＨレベルになる信号波形となる。そこで、ＡＮＤ回路１８において、ＰＷＭ制御信号５’とフリップフロップ出力信号１７の論理積をとり、最終的な新ＰＷＭ制御信号５を出力させる。新ＰＷＭ制御信号５は、ＰＷＭ信号発生回路１０９でＰＷＭ制御信号５’がＯＮ（Ｈレベル）になって、最初に瞬時電流（電流検出信号８）が、電流制限基準電圧値１４よりおおきくなった時点で次のＰＷＭ制御信号５’がＯＮ（Ｈレベル）になるまではＯＦＦ（Ｌレベル）状態が保持されることで過電流制御がなされた信号である。

【００４２】以上のように本実施の形態１のＤＣブラシレスモータの駆動制御装置は構成されているので、瞬間的に出力段手段１０４のスイッチング素子に流れる電流を制限し、素子を保護することができるとともに余分な電力をモータに供給しないので消費電力を抑制することができる。

【００４３】また、直流電源１０５における電圧の変動分、いわゆる瞬時電圧変動に対しても電圧変動対応制御部４において、ＰＷＭ指令値１０６にＢ／Ｃを乗じて新ＰＷＭ指令値１０６’とすることによりＰＷＭ制御信号のデュティを変えることで、リップル波形のない一定電圧をあたかもブラシレスモータ１０１に印加することとなり、電圧リップルによるポンプ特性の変動及びリップル波形の周波数を基本周波数とするポンプの振動を低減することができる。

【００４４】さらに、一般的に循環ポンプは、流量一定が望まれる。つまりポンプ定格点の定格流量以上の流量は不要となる。一方遠心ポンプにおいて消費電力は、流量が大きくなる程増大する。以上２点をまとめると、定格流量以上ではポンプ出力を低減することで、ポンプとしては充分の働きをしつつ、消費電力を抑制することができる。

【００４５】

【実施例】（実施例１）図４は直流電源から出力される電圧のリップル波形及び平滑用コンデンサの電流リップル波形を示したグラフである。

【００４６】図４において、２１は直流電源の電圧リップル波形であり、商用電源の周波数が６０Ｈｚ場合の全波整流の為、周期はほぼ２倍の１２０Ｈｚとなる。２２は平滑用コンデンサ２０３の電流リップル波形である。

【００４７】図４より、許容リップル電流を満足するコンデンサ容量に設定しても、電圧リップル波形２１のように６Ｖ程度もリップル電圧が発生することがわかる。

【００４８】（実施例２）図５は実施の形態１において過電流制御部により電流制限されている場合のモータ駆動コイルに流れる電流の波形を示したグラフであり、図６は電流制限されていない場合のモータ駆動コイルに流れる電流の波形を示したグラフである。

【００４９】図５において、電流制限がかかってＰＷＭ制御信号が強制的にＯＦＦ（Ｌレベル）になっても、モータ駆動コイルはインダクタンス成分をもっているので、急激にＯＦＦするのでなく所定の傾きをもってＯＦＦする。これはモータ駆動コイルに電流が流れている間、インダクタンス成分の値に比例してエネルギーが充

電されるため、モータ駆動コイルに直流電源１０５から電気が供給されなくてもそのエネルギーが放電することにより、モータ巻線に電流が流れるのである。

【００５０】図5及び図6より、モータの負荷トルクが大きい運転点で過電流制御がかかることがわかる。

【００５１】（実施例3）図7はDCブラシレスモータの特性（回転数－トルク）の関係を示したグラフである。

【００５２】図7において、過電流制御部9がある場合は実線で、無い場合は点線で表している。

【００５３】図7より、回転数がほぼ４２００（min^{-1}）以上の低負荷（０．１３５N・m以下）において電流制限はかからず、４２００（min^{-1}）以下の高負荷（０．１３５N・m以上）において電流制限がかかっていることがわかる。

【００５４】（実施例4）図8は電流制限ポイントをポンプの定格点に設定した場合に電流制限を設けた場合と設けない場合とでのポンプ特性を示したグラフである。この電流制限ポイントは、前記電流検出回路用抵抗6の値と電流制限基準電圧１４の値を変えることで、自由に設定することができる。

【００５５】図8より、ポンプ定格流量以上で電流制限がかかることで、ポンプ定格揚程以下では流量が低減しているが、ポンプとしては問題なく、逆にそれにより消費電力が、特に大流量側ではほぼ２０W程度低減することが分かる。

【００５６】（実施例5）図9は所定のポンプの定格点を達成する為のPWMデュティの直流電源の電圧依存性を示したグラフである。本実施例5において、下限値Bは１２０V、PWM指令値１０６に対応したデュティは１００％である。

【００５７】図9より、電源電圧が上昇するに従いほぼ（B／C）×１００％のPWMデュテイでポンプ定格点が達成されていることが分かる。例えば電源電圧が１４０Vの時、電圧変動対応制御部4では（１２０／１４０）×１００＝８５．７％が演算結果となるが、実際は約８８％になっている。この僅かな不一致はPWMのスイッチング損失の増大分の影響である。

【００５８】（実施例6）図１０は電圧変動対応制御部を任意のタイマ設定時間休止させた場合の自吸式ポンプの自給時間を示したグラフである。

【００５９】図１０より、電圧変動対応制御部4を休止させるタイマ時間を自吸時間とほぼ同等に設定すると自吸時間が約２５％程度低減することがわかる。尚、本実施例4において、下限値B＝１２０V、直流電源電圧検出の時間平均値C＝１３５V、タイマ期間中新PWM制御信号5のデュティを１００％とした場合の結果である。

【００６０】

【発明の効果】以上のように本発明のDCブラシレスモータの駆動制御装置とそれを備えた自吸式ポンプによれば、以下のような有利な効果を得ることができる。

【００６１】請求項１に記載の発明によれば、（１）電圧変動対応制御部において、直流電源の電圧の大きさに対応して新PWM指令値を決定し、PWM制御をかけることで電圧変動及び電圧リップルをもった電源でもポンプ等の機器の性能、消費電力等のバラツキ及び電圧リップルによる振動を低減することができるDCブラシレスモータの駆動制御装置を提供することができる。

【００６２】請求項２に記載の発明によれば、請求項１の効果に加え、（１）過電流制御部において、電流制限をかけることでスイッチング素子に流れる電流を制限し、素子を保護するとともに余分な電力をモータに供給しないので消費電力を抑制することができるDCブラシレスモータの駆動制御装置を提供することができる。

【００６３】（２）DCブラシレスモータをポンプに用いた場合、ポンプとしての定格流量以上の流量時、過電流制御部において、電流制限をかけることでモータトルクを制限し、結果として流量が制限され消費電力を抑制することができるDCブラシレスモータの駆動制御装置を提供することができる。

【００６４】請求項３に記載の発明によれば、請求項１又は２の効果に加え、（１）電圧変動の下限値Bでポンプ等の機器の性能を保証できるとともに、直流電源の電圧が下限値より大きくてもポンプ等の機器の性能を一定に保ちながら消費電力の増大、温度上昇の増大を抑制できるDCブラシレスモータの駆動制御装置を提供することができる。

【００６５】（２）電圧リップルに対しても瞬時にPWMパルス幅のデュティをB／Cに制御することで、平滑コンデンサの容量をアップさせることなく、電圧リップルによるポンプ等の機器の性能の変化や振動を抑制できるDCブラシレスモータの駆動制御装置を提供することができる。

【００６６】請求項４に記載の発明によれば、請求項１乃至３の内何れか一項の効果に加え、（１）簡単な構成で電流検出ができると共に、電流の瞬時値のピークカットができるDCブラシレスモータの駆動制御装置を提供することができる。

【００６７】請求項５に記載の発明によれば、請求項１乃至４の内何れか一項の効果に加え、（１）一時的にモータ出力を増大させ自吸性能を向上させることができ自給時間の短縮化を図ることができるDCブラシレスモータの駆動制御装置を備えた自吸式ポンプを提供することができる。

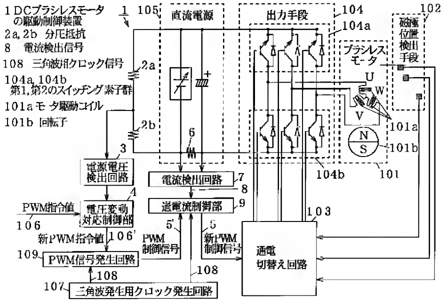
【図面の簡単な説明】

【図１】DCブラシレスモータの駆動制御装置の機能ブロック図

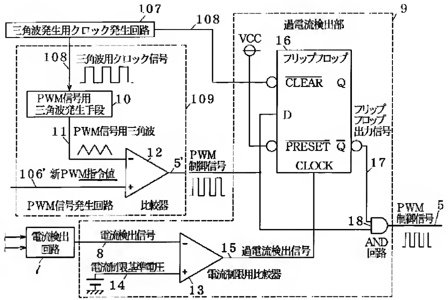
【図２】PWM信号発生回路及び過電流制御部の機能ブロック図

【図3】PWM信号発生回路及び過電流制御部の各信号波形図
【図4】直流電源から出力される電圧のリップル波形及び平滑用コンデンサの電流波形を示したグラフ
【図5】電流制限されている場合のモータ駆動コイルに流れる電流の波形を示したグラフ
【図6】電流制限されていない場合のモータ駆動コイルに流れる電流の波形を示したグラフ
【図7】DCブラシレスモータの特性（回転数－トルク）の関係を示したグラフ
【図8】電流制限を設けた場合と設けない場合とでのポンプ特性を示したグラフ
【図9】PWMデューティの直流電源の電圧依存性を示したグラフ
【図10】電圧変動対応制御部を任意のタイマ設定時間休止させた場合の自吸式ポンプの自給時間を示したグラフ
【図11】従来のDCブラシレスモータの駆動制御装置の機能ブロック図
【図12】直流電源の一例を示す回路図
【符号の説明】
1　DCブラシレスモータの駆動制御装置
2a，2b　分圧用抵抗
3　電源電圧検出回路
4　電圧変動対応制御部
5　新PWM制御信号
5'　PWM制御信号
6　抵抗
7　電流検出回路
8　電流検出信号
9　過電流制御部
10　PWM信号用三角波発生手段
11　PWM信号用三角波
12　比較器
13　電流制限用比較器
14　電流制限基準電圧
15　過電流検出信号
16　フリップフロップ
17　フリップフロップ出力信号
18　AND回路
21　電圧リップル波形
22　電流リップル波形
101　ブラシレスモータ
101a　モータ駆動コイル
101b　回転子
102　位置検出手段
103　通電切替え回路
104　出力手段
104a　第1のスイッチング素子群
104b　第2のスイッチング素子群
105　直流電源
106　PWM指令値
106'　新PWM指令値
107　三角波発生用クロック発生回路
108　三角波用クロック信号
109　PWM信号発生回路
201　商用電源
202　ダイオードブリッジ
203　コンデンサ

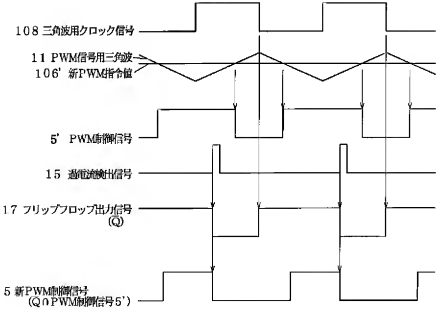
【図1】



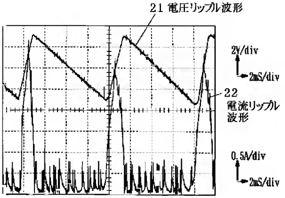
【図2】


107
三角波発生用クロック発生回路
108
9
過電流検出部
VCC
16
フリップフロップ
CLEAR
Q
D
PRESET
Q
CLOCK
108 三角波用クロック信号
PWM信号用
三角波発生手段
10
109
11 PWM信号用三角波
12
5'
PWM
制御信号
106' 新PWM指令値
PWM信号発生回路
比較器
フリップ
フロップ
出力信号
17
PWM
制御信号
5
18
AND
回路
電流検出
回路
電流検出信号
8
15 過電流検出信号
電流制限基準電圧
14
13
電流制限用比較器
7

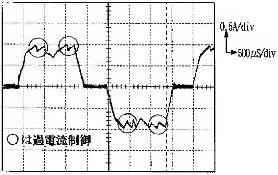
【図3】


108 三角波用クロック信号
11 PWM信号用三角波
106' 新PWM指令値
5' PWM制御信号
15 過電流検出信号
17 フリップフロップ出力信号
(Q)
5 新PWM制御信号
(Q∩PWM制御信号5')

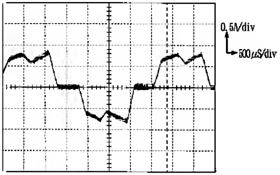
【図4】



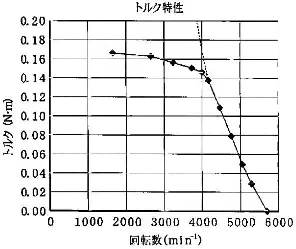
【図5】



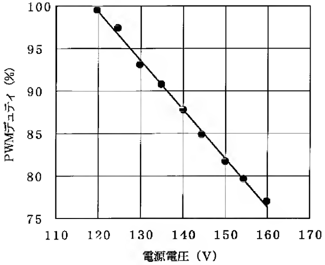
【図6】



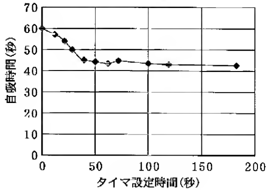
【図7】



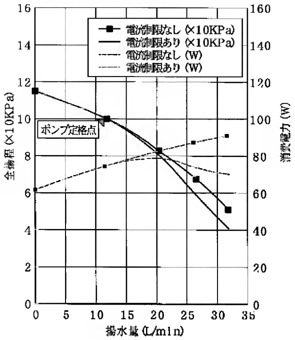
【図9】



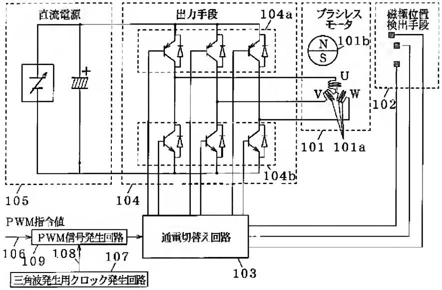
【図10】



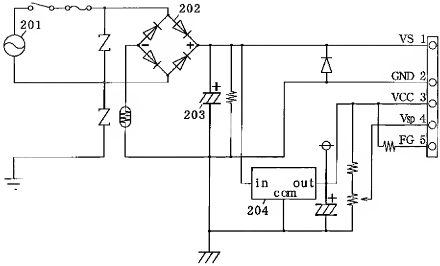
【図8】


電流制限なし (×10KPa)
電流制限あり (×10KPa)
電流制限なし (W)
電流制限あり (W)
ポンプ定格点
全揚程 (×10KPa)
消費電力 (W)
揚水量 (L/min)
0
5
10
15
20
25
30
35
2
4
6
8
12
14
16
40
60
80
100
120
140
160

【図11】


直流電源
出力手段
104a
ブラシレスモータ
磁極位置検出手段
N
S
101b
U
V
W
102
101
101a
104b
105
104
PWM指令値
PWM信号発生回路
通電切替え回路
106
109
108
107
103
三角波発生用クロック発生回路

【図12】



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